

**What is Claimed:**

1                   1.       A terahertz (THz) frequency radiation source to emit THz  
2       frequency radiation in a narrow wavelength band within a wavelength range of about  
3       3  $\mu\text{m}$  to 3000  $\mu\text{m}$  comprising:

4                           a broad bandwidth THz frequency emitter to generate broad bandwidth  
5       THz frequency radiation in an emitted wavelength band within the wavelength range,  
6       the emitted wavelength band having;

7                           a mid-band wavelength within the emitted wavelength band;  
8       and

9                           an emitted bandwidth greater than or equal to about .01 times  
10       the mid-band wavelength;

11                       a first planar waveguide optically coupled to the broad bandwidth THz  
12       frequency emitter to transmit the broad bandwidth THz frequency radiation;

13                       a disk resonator evanescently coupled to the first planar waveguide  
14       with a resonance wavelength band within the emitted wavelength band, the  
15       resonance wavelength band having a resonance wavelength bandwidth of less than  
16       or equal to about .25 times the emitted bandwidth; and

17                       a second planar waveguide evanescently coupled to the disk resonator  
18       to transmit THz frequency radiation in the narrow wavelength band, the narrow  
19       wavelength band being substantially equal to the resonance wavelength band of the  
20       disk resonator.

1                   2.       The THz frequency radiation source of claim 1, wherein the  
2       broad bandwidth THz frequency emitter is one of:

3                           a silicon/silicon-germanium quantum well structure intersubband  
4       electroluminescence emitter;

5                           a resonant state transition emitter;

6                           a non-quantum well, doped group IV material emitter;

7 a blackbody radiation source; or

8 an incandescent radiation source.

1 3. The THz frequency radiation source of claim 1, wherein:

2 the first planar waveguide includes;

3 a first waveguide portion having a substantially rectangular  
4 cross-section and a bottom surface, the first waveguide portion formed of a  
5 waveguiding material, the waveguiding material being substantially  
6 transmissive in the emitted wavelength band and having a waveguide index  
7 of refraction; and

8 a first pedestal portion connecting a central portion of the  
9 bottom surface of the first waveguide portion to a substrate;

10 the disk resonator includes;

11 a resonator portion having a substantially cylindrical shape and  
12 a bottom surface, the resonator portion formed of the waveguiding material;  
13 and

14 a resonator pedestal portion connecting a central portion of the  
15 bottom surface of the resonator portion to the substrate; and

16 the second planar waveguide includes;

17 a second waveguide portion having a substantially rectangular  
18 cross-section and a bottom surface, the second waveguide portion formed of  
19 the waveguiding material; and

20 a second pedestal portion connecting a central portion of the  
21 bottom surface of the second waveguide portion to the substrate.

1 4. The THz frequency radiation source of claim 3, wherein the  
2 waveguiding material is a substantially undoped material formed of one or more  
3 group IV elements.

1                   5.       The THz frequency radiation source of claim 4, wherein the  
2 substantially undoped material formed of one or more group IV elements includes at  
3 least one of:

4                   a crystalline material formed of one group IV element;

5                   a crystalline material formed of an alloy of group IV elements;

6                   an amorphous material formed of one group IV element;

7                   an amorphous material formed of an alloy of group IV elements;

8                   an amorphous crystalline material formed of one group IV element;

9                   an amorphous crystalline material formed of an alloy of group IV  
10 elements;

11                  a polycrystalline material formed of one IV element; or

12                  a polycrystalline material formed of an alloy of group IV elements.

1                   6.       The THz frequency radiation source of claim 4, wherein the  
2 substantially undoped material formed of one or more group IV elements is selected  
3 from a group consisting of: diamond, crystalline silicon, crystalline germanium,  
4 crystalline silicon carbide, crystalline silicon germanium, polycrystalline silicon,  
5 amorphous diamond, amorphous silicon, and amorphous germanium.

1                   7.       The THz frequency radiation source of claim 3, wherein:

2                   the first pedestal portion of the first planar waveguide is formed of the  
3 waveguiding material;

4                   the resonator pedestal portion of the disk resonator is formed of the  
5 waveguiding material;

6                   the second pedestal portion of the second planar waveguide is formed  
7 of the waveguiding material; and

8                   the substrate is formed of the waveguiding material.

1                   8.       The THz frequency radiation source of claim 3, wherein:

2                   the first pedestal portion of the first planar waveguide is formed of a  
3 pedestal material, the pedestal material having a pedestal index of refraction, the  
4 pedestal index of refraction being less than the waveguide index of refraction; and

5                   the resonator pedestal portion of the disk resonator is formed of the  
6 pedestal material; and

7                   the second pedestal portion of the second planar waveguide is formed  
8 of the pedestal material.

1                   9.       The THz frequency radiation source of claim 1, wherein the  
2 mid-band wavelength within the emitted wavelength band is a peak wavelength of  
3 the emitted wavelength band.

1                   10.     The THz frequency radiation source of claim 1, wherein the  
2 emitted wavelength band includes wavelengths within the wavelength range for  
3 which the broad bandwidth THz frequency emitter generates an emitted spectral  
4 power greater than a predetermined spectral power.

1                   11.     The THz frequency radiation source of claim 1, further  
2 comprising:

3                   an additional disk resonator evanescently coupled to the first planar  
4 waveguide with an additional resonance wavelength band within the emitted  
5 wavelength band, the additional resonance wavelength band;

6                   having an additional resonance wavelength bandwidth of less  
7 than or equal to about .25 times the emitted bandwidth; and

8                   being distinct from the resonance wavelength band; and

9                   a third planar waveguide evanescently coupled to the additional disk  
10 resonator to transmit THz frequency radiation in the additional resonance wavelength  
11 band of the additional disk resonator.

- 20 -

1                   12.    A terahertz (THz) frequency radiation detector to detect a  
2    narrow wavelength band of THz frequency radiation within a wavelength range of  
3    about 3  $\mu\text{m}$  to 3000  $\mu\text{m}$ , comprising:

4                   a broad bandwidth THz frequency radiation detector with a detection  
5    wavelength band within the wavelength range, the detection wavelength band  
6    having;

7                   a shortest detected wavelength within the detection wavelength  
8    band; and

9                   a detection bandwidth greater than or equal to about .01 times  
10   the shortest detected wavelength; and

11                  a narrow bandwidth THz frequency band wavelength selector coupled  
12   to the broad bandwidth THz frequency radiation detector to select and transmit only  
13   THz frequency radiation in the narrow wavelength band to the broad bandwidth THz  
14   frequency radiation detector, the narrow bandwidth THz frequency band wavelength  
15   selector including;

16                  a first planar waveguide optically to receive input radiation;

17                  a disk resonator evanescently coupled to the first planar  
18   waveguide with a resonance wavelength band within the detection  
19   wavelength band, the resonance wavelength band having a resonance  
20   wavelength bandwidth of less than or equal to about .25 times the detection  
21   wavelength bandwidth; and

22                  a second planar waveguide evanescently coupled to the disk  
23   resonator and optically coupled to the broad bandwidth THz frequency  
24   radiation detector to transmit the narrow wavelength band of THz frequency  
25   radiation from the disk resonator to the broad bandwidth THz frequency  
26   radiation detector, the narrow wavelength band being substantially equal to  
27   the resonance wavelength band of the disk resonator.

1                   13.    The THz frequency radiation detector of claim 12, wherein the  
2    broad bandwidth THz frequency radiation detector is one of:

- 21 -

a silicon/silicon-germanium quantum well structure detector;  
a resonant state transition detector;  
a non-quantum well, doped group IV material detector; or  
a bolometer.

14. The THz frequency radiation detector of claim 12, wherein:

the first planar waveguide includes;

a first waveguide portion having a substantially rectangular cross-section and a bottom surface, the first waveguide portion formed of a waveguiding material, the waveguiding material being substantially transmissive in the narrow wavelength band and having a waveguide index of refraction; and

a first pedestal portion connecting a central portion of the bottom surface of the first waveguide portion to a substrate;

the disk resonator includes;

a resonator portion having a substantially cylindrical shape and a bottom surface, the resonator portion formed of the waveguiding material; and

a resonator pedestal portion connecting a central portion of the bottom surface of the resonator portion to the substrate; and

the second planar waveguide includes;

a second waveguide portion having a substantially rectangular cross-section and a bottom surface, the second waveguide portion formed of the waveguiding material; and

a second pedestal portion connecting a central portion of the bottom surface of the second waveguide portion to the substrate.

1                   15.    The THz frequency radiation detector of claim 14, wherein the  
2    waveguiding material is a substantially undoped material formed of one or more  
3    group IV elements.

1                   16.    The THz frequency radiation detector of claim 15, wherein the  
2    substantially undoped material formed of one or more group IV elements includes at  
3    least one of:

4                   a crystalline material formed of one group IV element;

5                   a crystalline material formed of an alloy of group IV elements;

6                   an amorphous material formed of one group IV element;

7                   an amorphous material formed of an alloy of group IV elements;

8                   an amorphous crystalline material formed of one group IV element;

9                   an amorphous crystalline material formed of an alloy of group IV  
10    elements;

11                  a polycrystalline material formed of one IV element; or

12                  a polycrystalline material formed of an alloy of group IV elements.

1                   17.    The THz frequency radiation detector of claim 15, wherein the  
2    substantially undoped material formed of one or more group IV elements is selected  
3    from a group consisting of: diamond, crystalline silicon, crystalline germanium,  
4    crystalline silicon carbide, crystalline silicon germanium, polycrystalline silicon,  
5    amorphous diamond, amorphous silicon, and amorphous germanium.

1                   18.    The THz frequency radiation detector of claim 14, wherein:

2                   the first pedestal portion of the first planar waveguide is formed of the  
3    waveguiding material;

4                   the resonator pedestal portion of the disk resonator is formed of the  
5    waveguiding material;

6                   the second pedestal portion of the second planar waveguide is formed  
7 of the waveguiding material; and

8                   the substrate is formed of the waveguiding material.

1                   19.    The THz frequency radiation detector of claim 14, wherein:

2                   the first pedestal portion of the first planar waveguide is formed of a  
3 pedestal material, the pedestal material having a pedestal index of refraction, the  
4 pedestal index of refraction being less than the waveguide index of refraction; and

5                   the resonator pedestal portion of the disk resonator is formed of the  
6 pedestal material; and

7                   the second pedestal portion of the second planar waveguide is formed  
8 of the pedestal material.

1                   20.    The THz frequency radiation detector of claim 12, wherein the  
2 detection wavelength band includes wavelengths within the wavelength range for  
3 which the broad bandwidth THz frequency radiation detector detects radiation having  
4 a spectral power greater than a predetermined spectral power.

1                   21.    The THz frequency radiation detector of claim 12, further  
2 comprising:

3                   an additional broad bandwidth THz frequency radiation detector with  
4 an additional detection wavelength band within the wavelength range, the additional  
5 detection wavelength band having;

6                   an additional shortest detected wavelength within the detection  
7 wavelength band; and

8                   an additional detection bandwidth greater than or equal to  
9 about .01 times the additional shortest detected wavelength; and

10                  wherein;



- 24 -

11                   the narrow bandwidth THz frequency band wavelength selector  
12           is further coupled to the additional broad bandwidth THz frequency radiation  
13           detector to select and transmit only THz frequency radiation in an additional  
14           narrow wavelength band to the additional broad bandwidth THz frequency  
15           radiation detector; and

16                   the narrow bandwidth THz frequency band wavelength selector  
17           further includes;

18                   an additional disk resonator evanescently coupled to the  
19           first planar waveguide with an additional resonance wavelength band  
20           within the detection wavelength band, the additional resonance  
21           wavelength band;

22                   having an additional resonance wavelength  
23           bandwidth of less than or equal to about .25 times the  
24           additional detection wavelength bandwidth; and

25                   being distinct from the resonance wavelength  
26           band; and

27                   a third planar waveguide evanescently coupled to the  
28           additional disk resonator and optically coupled to the additional broad  
29           bandwidth THz frequency radiation detector to transmit the additional  
30           resonance wavelength band of THz frequency radiation from the  
31           additional disk resonator to the additional broad bandwidth THz  
32           frequency radiation detector.